**FY 2003 ESTIMATES**
**BUDGET SUMMARY**

**BIOLOGICAL AND PHYSICAL RESEARCH (BPR) ENTERPRISE and**
**OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER (OCHMO)**
**SUMMARY OF RESOURCE REQUIREMENTS**
***Web Address: http://SpaceResearch.nasa.gov***

| | FY 2001 OP PLAN REVISED | FY 2002 INITIAL OP PLAN | FY 2003 PRES BUDGET | Page Number |
|---|---|---|---|---|
| | | *(Millions of Dollars)* | | |
| **Biological and Physical Research and Technology** | **312.9** | **277.9** | **321.8** | SAT 2-10 |
| Bioastronautics Research (BR)* | 101.0 | 95.6 | 113.0 | SAT 2-10 |
| Advanced Human Support Technology (AHST) | 30.8 | 26.3 | (32.2) | |
| Biomedical Research and Countermeasures (BR&C) | 69.2 | 69.3 | (80.8) | |
| [Construction of Facilities – included in BR&C number] | [11.6] | [9.8] | [2.8] | |
| Minority University Research and Education Program (MUREP) | 1.0 | | | |
| Fundamental Space Biology (FSB) | 40.6 | 35.3 | 56.0 | SAT 2-14 |
| Physical Sciences Research (PSR) | 130.4 | 120.0 | 134.1 | SAT 2-17 |
| Space Product Development (SPD)* | 29.2 | 17.0 | 14.8 | SAT 2-20 |
| Space Product Development (SPD) | 13.7 | 16.8 | (14.6) | |
| Mission Integration (MI) | 15.5 | 0.2 | (0.2) | |
| Health Research** | 11.7 | 10.0 | 3.9 | SAT 2-23 |
| **ISS Research Capability (ISSRC)** (non-add FY 2001 number included for comparison purposes) | **[457.4]** | **371.3** | **347.2** | SAT 2-6 |
| **Institutional Support** | **49.3** | **170.9** | **173.3** | SAT 2-26 |
| **TOTAL** (numbers may not add due to rounding) | **362.2** | **820.0** | **842.3** | |
| **Direct FTEs** | **332** | **1,030** | **1,025** | |

* In the FY 2003 structure, Bioastronautics Research and Space Product Development will each be a single line; lower-level AHST, BR&C, SPD, and MI breaks are shown for comparison purposes only.

** In FY 2001, the content of Health Research was divided among BPR ($3.2M), HEDS ($5.2M), and the Office of the Chief Health and Medical Officer (OCHMO) ($3.3M). In the FY 2002 column, the BPR portion ($1.2M) has been transferred into BR&C, and no longer shows up in Health Research. In the FY 2003 column, the HEDS portion ($5.9M) has been transferred to HEDS, and the remaining $3.9M funds OCHMO. None of the Health Research content areas have been eliminated.

**BIOLOGICAL AND PHYSICAL RESEARCH ENTERPRISE**
**AND OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER**

**DISTRIBUTION OF PROGRAM AMOUNT BY INSTALLATION**

| | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|
| | *(Millions of Dollars)* | | |
| Johnson Space Center | 123.6 | 202.0 | 225.0 |
| Kennedy Space Center | 8.2 | 19.0 | 18.8 |
| Marshall Space Flight Center | 70.7 | 259.1 | 246.7 |
| Ames Research Center | 60.8 | 104.2 | 116.4 |
| Langley Research Center | 0.1 | 3.4 | 3.5 |
| Glenn Research Center | 52.3 | 111.5 | 103.3 |
| Goddard Space Flight Center | 5.8 | 5.8 | 3.0 |
| Jet Propulsion Laboratory | 15.9 | 34.7 | 43.3 |
| Dryden Flight Research Center | -- | -- | -- |
| Stennis Space Center | -- | -- | -- |
| Headquarters | 24.8 | 80.3 | 82.3 |
| **Total** (numbers may not add due to rounding) | **362.2** | **820.0** | **842.3** |

**STRATEGIC PLAN LINKAGE TO THIS BUDGET**

As humans make the first steps off of the Earth and into space, we enter a new realm of opportunity to explore profound questions, new and old, about the laws of nature. At the same time, we enter an environment unique in our evolutionary history that poses serious physiological and psychological challenges. BPR addresses the challenges of space flight through basic and applied research on the ground and in space, and seeks to exploit the rich opportunities of space flight for fundamental research in the biological and physical sciences, as well as in commercial development. BPR seeks to understand the basic questions underlying human space flight while conducting research to enable efficient and effective systems for protecting and sustaining humans in space; and to understand nature's forces in space.

In FY 2001, the Biological and Physical Research (BPR) Enterprise was created as NASA's fifth strategic enterprise. BPR closed its first fiscal year with a significant record of accomplishment. It expanded its interagency research collaboration, establishing a new memorandum of understanding with the United States Department of Agriculture, conducting a joint research solicitation with the National Cancer Institute, and continuing work under 18 other agreements with the National Institutes of Health. A BPR investigator received the Nobel Prize in physics for ground-based research that he plans to extend and expand on the International Space Station (ISS). Outfitting ISS for research began with the delivery of the Human Research Facility in March 2001. Two research equipment racks were delivered to the ISS in mid-April, and an additional two at the beginning of Expedition 3 in August.

BPR initiated a program of research on the ISS to take advantage of available resources during the construction phase. The ISS Expedition 1 and 2 teams were able to exceed expectations for meeting research objectives of the planed experiments, with only one unsuccessful experiment due to technical reasons.

In FY 2002, BPR will continue to increase knowledge and demonstrate key technology capabilities for humans in space, address critical questions in crew health and safety, and physical sciences and commercial research payloads will be flown on both the Space Shuttle and aboard ISS. A highlight of FY 2002 is the planned flight of STS-107 in July. The Space Station research program is on-track to deliver another five equipment racks on-orbit by the end of 2002. Also in FY 2002, BPR will initiate a procurement activity leading to release of the final Request for Proposal (RFP) for a contract to manage ISS utilization by a Non-Governmental Organization (NGO). Working with the scientific community, its advisory committees, and the Administration, BPR will complete the development of research priorities across its portfolio of research endeavors to provide a basis for critical resource allocation decisions. In the area of public outreach and education, BPR plans to develop electronic and printed educational materials that focus on biological and physical research targeting K-12 and university students.

In FY 2003, BPR will implement its research priorities and develop ISS flight facilities to achieve a prioritized and productive research program. BPR will also work with Space Research Museum Network members to explore opportunities for the development of projects, special events, or workshops focused on the life sciences and biology-related research themes to attract and engage public audiences. In addition, BPR will make available to wide audiences an online database of Commercial Space Center activities, including publications listings, patents, and other information useful to the general public.

**Enterprise Strategic Plan Goals:**

Goal 1: Conduct research to enable safe and productive human habitation of space.
BPR conducts fundamental and applied research in the biological and physical sciences to reduce the health risks of space travel. We conduct research on technology for efficient, self-sustaining life-support systems to provide safe, hospitable environments for space exploration, and develop advanced technologies for healthcare delivery. Advances in healthcare first developed for the space flight environment are applied on Earth to enhance healthcare.

Goal 2: Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology.
The space environment offers a unique laboratory in which to study biological and physical processes. Researchers take advantage of this environment to conduct experiments that are impossible on Earth. For example, most combustion processes on Earth are dominated by the fact that hot gases rise. In space, this is not the case, and hidden properties of combustion emerge. Materials scientists study the role of gravity in important industrial processes. Physicists take advantage of microgravity to study exotic forms of matter that are better handled in space. Biological researchers investigate the role of gravity in life processes and how the space environment experience affects living organisms. The knowledge derived from BPR's diverse research will inform and expand scientific understanding, support economic and technological progress, and help to enable the human exploration of space.

Goal 3: Enable and promote commercial research in space.
BPR provides knowledge, policies, and technical support to facilitate industry investment in space research. BPR will continue to enable commercial researchers to take advantage of space flight opportunities for proprietary research. The commercial sector will

grow to become the premier mechanism for applying space knowledge to benefit the American people, and commercial applications of space knowledge will generate new products, new jobs, and new spin-off companies.

Goal 4: Use space research opportunities to improve academic achievement and the quality of life.
BPR seeks to use its research activities to encourage educational excellence and to improve scientific literacy from primary school through the university level and beyond. We deliver value to the American people by facilitating access to the experience and excitement of space research. BPR strives to involve society as a whole in the transformations that will be brought about by research in space.

| Enterprise Goals | Science Objectives | Research Focus Areas | Enabling Program/Mission |
|---|---|---|---|
| 1. Conduct research to enable safe and productive human habitation of space. | • Conduct research to ensure the health, safety, and performance of humans living and working in space. | • Biomedical Research and Countermeasures<br>• Advanced Human Support Technology | ISS, STS-107, Ground-Based Research |
| | • Conduct physical science research on planetary environments to ensure safe and effective missions of exploration. | • Physical Sciences Research | Future |
| | • Conduct research on biological and physical processes to enable future missions of exploration. | • Fundamental Space Biology<br>• Physical Sciences Research | ISS, STS-107, Ground-Based Research |
| 2. Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology. | • Investigate chemical, biological and physical processes in the space environment, in partnership with the scientific community. | • Fundamental Space Biology<br>• Physical Sciences Research | ISS, STS-107, Ground-Based Research |
| | • Develop strategies to maximize scientific research output on the International Space Station and other space research platforms. | • All Divisions of Biological and Physical Research | ISS, STS-107, Ground-Based Research |
| 3. Enable and promote commercial research in space. | • Assure that NASA policies facilitate industry involvement in space research.<br>• Systematically provide basic research knowledge to industry.<br>• Provide technical support for companies to begin space research.<br>• Foster commercial research endeavors with the International Space Station and other assets. | • Space Product Development | ISS, STS-107, Ground-Based Research |
| 4. Use space research opportunities to improve academic achievement and quality of life. | • Engage and involve the public in research in space.<br>• Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets. | • All Divisions of Biological and Physical Research | ISS, STS-107, Ground-Based Research |

**BASIS OF FY 2003 FUNDING REQUIREMENT**

**INTERNATIONAL SPACE STATION RESEARCH CAPABILITY PROGRAM**

| | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|
| | | *(Millions of Dollars)* | |
| **ISS Research Capability Program Development*** | **[457.4]**** | **371.3** | **347.2** |
| (lower-level breaks for information only) | | | |
| Bioastronautics Research | [40.2] | [30.2] | [33.9] |
| Earth Observation Systems | [4.0] | [3.4] | [3.4] |
| Fundamental Space Biology | [75.7] | [58.0] | [42.1] |
| Physical Sciences Research | [145.7] | [114.3] | [113.0] |
| Space Product Development | [19.7] | [15.5] | [15.8] |
| Engineering Technology (FY 2001 only) | [3.0] | | |
| Multi-User Systems and Support (FY 2002 and out) | | [149.9] | [138.9] |
| Flight Multi-User Hardware and Support (FY 2001 only) | [52.0] | | |
| Payload Integration and Operations (FY 2001 only) | [117.0] | | |

* (numbers may not add due to rounding)

** (included in HEDS in FY 2001; shown for comparison purposes only)

**DESCRIPTION/JUSTIFICATION**

At the beginning of FY 2002, the Research portion of the International Space Station Program was transferred from the Human Space Flight Appropriation into the BPR account in the Science, Aeronautics, and Technology appropriation. The International Space Station Research Capability (ISSRC) Program encompasses the research-discipline-based facility development and utilization projects and multi-user systems support for the science, as well as technological and commercial payloads planned to utilize the International Space Station (ISS) as a research platform. The ISSRC includes the development of research facilities, experiment-unique equipment, multi-user payload hardware, and the ground facilities, software, and tools to implement the utilization tasks. Utilization support services are provided to both U.S. and International Partners, and include services for payload planning and engineering support, crew and user team training, sub-rack- and sub-pallet-level payload integration, ground processing, and on-orbit payload operations for all research related hardware and software on-board the ISS. All Principal Investigator grants are funded through separate NASA Science Enterprise programs and are not included in the ISSRC.

The ISSRC provides the foundation to enable the NASA Science Enterprises to utilize the ISS as an interactive laboratory and observatory in space to advance scientific, exploration, engineering, and commercial activities. As a microgravity laboratory, the ISS is being used to advance fundamental scientific knowledge, foster new scientific discoveries for the benefit of the U. S., and develop beneficial applications derived from long-term, space-based research. The ISS is the world's premier facility for studying the role of gravity on biological, physical, and chemical systems. The program is delivering the capability to perform unique, long-duration, space-based research in molecular, cellular, comparative, and developmental biology, human physiology, biotechnology, fluid

physics, combustion science, materials science, and fundamental physics. The experience and knowledge gained from long-duration human presence on the ISS is helping us learn how to more safely and effectively live and work in space. ISS also provides a unique platform for making observations of the Earth's surface and atmosphere, the sun, and other astronomical objects, as well as the space environment and its effects on new spacecraft technologies.

**Scientific Question and Program Approach**

BPR has identified four major overarching goals which will be pursued through ISS Research: (1) conduct research to enable the safe and productive human habitation of space; (2) use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology; (3) enable and promote commercial research in space; and (4) use space research opportunities to improve academic achievement and the quality of life.

BPR will also prioritize its ISS research activities using input from an external committee, the Office of Science and Technology Policy, and BPR's standing advisory committees. Such priorities, to be identified by August 2002, will enable BPR to make the most effective use of the research resources available, particularly those of the ISS. Content and dates identified below may change based on this prioritization process.

**LINKAGES TO STRATEGIC AND PERFORMANCE PLANS**

**Strategic Plan Goal Supported:** Develop strategies to maximize scientific research output on the ISS and other space research platforms.
**Strategic Plan Objectives Supported:** Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology.
**Performance Plan Metrics Supported:** Goal 3B8: In close coordination with the research community, allocate flight resources and develop facilities to achieve a balanced and productive research program. In FY 2001, BPR received a "Green" for meeting Goal 1H5: Continue initial research on the International Space Station by conducting 6 to 10 investigations.

| Milestones | Plan in FY 2003 Budget | Plan in FY 2002 Budget | Plan in FY 2001 Budget | FY 2002 - FY 2003 Change | Comment |
|---|---|---|---|---|---|
| UF-2 Launch | 3rd Qtr., FY02 | 2nd Qtr., FY02 | 4/99 | 1 Qtr. | Space Shuttle Program Manifest |
| ULF1 Launch | 1st Qtr., FY03 | 4th Qtr., FY02 | 6/02 | 1 Qtr. | Space Shuttle Program Manifest |
| Human Research Facility-2 | 1st Qtr., FY03 | 4th Qtr., FY02 | | 1 Qtr. | [to be delivered to orbit on ULF1 Mission] |

| **Lead Center**: JSC | **Performing Centers: ARC, GSFC, JPL, JSC, KSC, LaRC, & MSFC** | **Interdependencies:** International Partners, ISS Vehicle Program |
|---|---|---|
| **Subsystem** | **Builder** | **Status** |
| Human Research Facilities (HRF) 1 & 2 | Boeing, MSFC/JSC | HRF-1 on orbit |
| EXPRESS Racks (ER) 1-8 | Boeing, MSFC | ER1, 2, 4, and 5 on orbit; ER3 launch on UF-2 5/02 |
| Window Observational Research Facility (WORF) | Boeing, MSFC | |
| Habitat Holding Racks (HHR) 1 & 2 | Boeing, MSFC/ARC | |
| Materials Sciences Research Facility (MSRF) 1 | NASA/ESA | |
| Fluids Integrated Rack (FIR) | GRC | |
| Combustion Integrated Rack (CIR) | GRC | |
| Life Science Glovebox (LSG) | NASDA | |
| Microgravity Science Glovebox (MSG) | ESA | MSG launch on UF-2 5/02 |
| Minus Eighty-Degree Life Sciences Freezer for the ISS (MELFI) | ESA | |
| Cryogenic Freezer | ESA | |
| Low Temperature Microgravity Physics Facility (LTMPF) | Ball Aerospace, JPL | |
| **Instruments** | **Builder** | **Pr. Investigator** |
| Multiple | Multiple | Multiple |
| **Launch Vehicle** | **Tracking/Comm** | **Data** |
| Multiple Launches, Shuttle | ISS KU Band | Multiple Data Transmissions |

## PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Delivery of the U.S. Laboratory in February 2001 set the stage to begin ISS Research in earnest, and the astronauts have completed 47 experiments aboard the Station. During FY 2001, initial Lab outfitting was accomplished with deployment of five racks (the Human Research Facility-1 and four EXPRESS Racks). Two additional racks are planned for on-orbit deployment in the third quarter of FY 2002: the Microgravity Sciences Glovebox and one EXPRESS Rack. The first three long-term Expeditions have been completed and Expedition 4 is currently aboard the ISS. The Expedition 1 (October 2000 to February 2001) crew focused on research outfitting, but conducted some early Earth observations, education experiments, biological crystal growth experiments, technology development, and human research data collection. The Expedition 2 (February 2001 to August 2001) crew began a more robust program of scientific research, consisting of experiments primarily focused on biomedical research in the areas of the radiation environment, bone loss and changes in reflexes. Other experiments included plant germination and growth, Earth observations, macromolecular crystal growth, and physics experiments using colloids to model the crystallization process. Research on Expedition 3 (August 2001-December 2001) included investigation of the mechanism of space flight-induced orthostatic intolerance, which has symptoms such as lightheadedness, palpitations, tremulousness, and poor concentration; a study of pulmonary function in space as affected by extravehicular activities; a study of the risk factors associated with kidney stone formation during and after space flight; and the use of new techniques for studying structural biology in space. BPR's Physics of Colloids in Space experiment is already yielding unique new data on never-before-seen colloidal crystallization patterns. Additional experiment runs will be carried out in order to confirm the exciting earlier results on the unexpected power law for crystal growth. The ultimate application of this research may be in the fabrication of photonic devices for optical communications and electronics. Expeditions 4, 5, and 6 will fly during FY 2002 and experiments will continue in the areas of biomedical research, biotechnology, microgravity research, materials science, agriculture, and Earth observations. NASA continues to prepare for on-orbit research through the preparation and testing of five additional research racks, ongoing payload crew training, and operation of the ground support infrastructure (including the Payload Operations Center).

Fiscal Year 2002 will be a transition year during which the program will be re-baselined and a new management plan for program oversight will be developed for implementation in FY 2003.

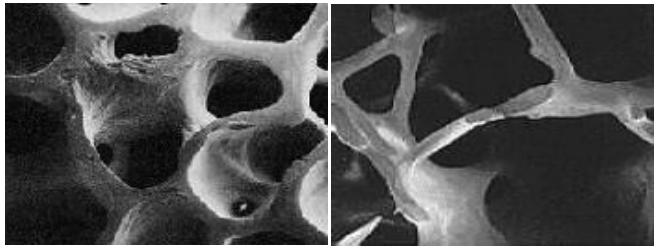
## PROGRAM PLANS FOR FY 2003

In the second quarter of FY 2003, Lab outfitting will continue with the planned delivery of three racks: the Window Observational Research Facility, Human Research Facility-2, and one EXPRESS Rack. By the end of FY 2003, a total complement of 10 research racks will be on-orbit and operating in the U.S. Laboratory. In FY 2003, Expedition 6 continues, followed by Expeditions 7 and 8. Middeck locker level experiments are planned to continue in the areas of biomedical research, biotechnology, microgravity research, materials science, agriculture, and Earth observations. The S3 U.S. Truss Segment is planned for launch in the fourth quarter of FY 2003; this segment provides the attach site for the external payloads planned for initial deployment no earlier than 2004.

**BASIS OF FY 2003 FUNDING REQUIREMENT**

**BIOASTRONAUTICS RESEARCH PROGRAM**

| | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|
| **Research Program ($ in Millions)** | **101.0** | **95.6** | **113.0** |



Normal (left) and osteoporotic (right) human bone. BPR-funded research on rats shows that low-level vibration prevents decreased bone formation in a simulated microgravity environment; vibration therapy holds promise as a countermeasure for the bone loss that occurs during long-duration space flight.

**DESCRIPTION/JUSTIFICATION**

The Bioastronautics Research (BR) Program has two main objectives that support space flight crew health, safety and performance. The first is to understand physiological and psychological adaptation to space flight and return to Earth in order to develop countermeasures and technologies that will mitigate risks to the crew. The second is to develop technologies that will improve spacecraft habitability, environmental controls, planetary habitability, and space systems. The primary goal of this research is to improve the health and safety of space travelers; however, this research also has the potential to make significant contributions to medical care on Earth. For example, space flight can provide models for exploring osteoporosis and other diseases of muscle and bone. The parallels between aging and space travel are currently under study by researchers at NASA and the National Institute on Aging. BPR research on life support technologies is intended to reduce the cost of space travel. This technology may also find application in process control systems for industry, and may even help to provide clean environments in homes, vehicles, and offices.

**PROGRAM AREA**

BR performs research and develops technology for next-generation systems that will enable humans to live and work safely and effectively in space. Special emphasis is placed on those technologies that will have a dramatic impact on the reduction of required mass, power, volume, and crew time, and on those that will increase safety and reliability. The program funds technologies that address both the near- and long-term needs of space travel, and places a high priority on making NASA technologies available to the private sector for Earth applications. It also performs the scientific research that develops the knowledge base and technologies required to preserve health, morale, performance, and safety in astronaut crews. Program research results are directed to providing a better understanding of physiological, psychological, and behavioral adaptations to space flight that will enable improvements in: predictions of astronaut health and safety risks; diagnostics of health status; management of medical and behavioral problems; establishment of human physiological norms for space flight; protection of humans from the negative physiological and behavioral effects of space flight; and tools available for rehabilitation of crewmembers after space flight.

**GOALS**

(1) to demonstrate and validate full self-sufficiency in air, water, and food recycling technology for use in space vehicles;
(2) to demonstrate and validate integrated, fully autonomous environmental monitoring and control systems;
(3) to validate human factors engineering technology and protocols to ensure maintenance of high ground and flight crew skills

during long-duration missions;
(4) to reduce the risk to crew health from space radiation;
(5) to reduce the risk of acute and chronic crew health, psychological and behavioral problems;
(6) to increase crew productivity in flight, and to ensure complete post-flight rehabilitation of the crew for a full, healthy life on Earth; and
(7) to transfer biomedical knowledge and technology gained through research on the ground and in space to the Earth-based medical community.

**CONTENT**

The Bioastronautics Research Program uses ground-based and flight research grants, contracts, cooperative agreements and interagency agreements supporting Shuttle and Space Station experiments to develop flight studies for Shuttle mid-deck missions and Space Station in the areas of countermeasure development, and medical research. It also funds Research and Technology Development (R&TD) activities through the same opportunities.

| Milestones | Plan in the FY 2003 Budget | Plan in the FY 2002 Budget | Plan in the FY 2001 Budget | FY 2002 - FY 2003 Change | Comment/Status |
|---|---|---|---|---|---|
| Release 2 NRAs | 2/02<br>10/02 | 2/02<br>N/A | 2/02<br>N/A | None<br>N/A | AHST NRA released February 2002; BR&C NRA released October 2001 |
| Award Grants From NRA 01-OBPR-03 | 4/02 | | | | |
| Research Experiments On STS-107 | 7/02 | 1st Quarter, FY 2002 | 5/00 | 7-9-month slip | Launch delays due to manifest changes |
| Establish and Pursue Science Priorities | 8/02 Final Report | | | | Revalidation of scientific research content and prioritization |
| Establish New NASA Specialized Center of Research and Training (NSCORT) | 10/02 | 1/02 | 1/02 | 10 Month Slip | Budget constraints forced deferral to FY 2003 |

**MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR**

The world's smallest high-performance mass spectrometer (the quadrupole mass spectrometer array), contained within the Trace Gas Analyzer, was delivered to the International Space Station in February. The device, which can detect ammonia, hydrazine, oxygen, and nitrogen and water leaks, is expected to play a critical role in detecting leaks outside the orbiting facility. The Immobilized Microbe Microgravity Water Processing System (IMMWPS) was successfully demonstrated in ground tests, and a simulation of the experiment's installation aboard the Shuttle mid-deck was performed. In another ground-based study, midodrine was found to maintain blood pressure in humans exposed to 16-days of head-down-tilt bed-rest. This drug will be tested on ISS and Shuttle astronauts following their return from space, becoming the first experiment in NASA's Countermeasure Evaluation and

Validation Project. An investigation funded by the BR program showed that intermittent vibration (10 minutes per day) prevented the bone loss in rats that normally occurs when the weight of the body is supported so that the limbs no longer carry weight. Clinical trials are underway to study this intervention on humans here on Earth, and a proposal for using the intervention on astronauts has been reviewed and received a passing score. This countermeasure would be tested by the astronauts on the ISS after successful validation in clinical trials. A set of polyethylene slabs was flown on the Space Station to provide local shielding for one astronaut's sleeping quarters, based on calculations developed by NASA researchers that predict superior shielding properties for this material against space radiation. A reduction of approximately 30% in radiation levels relative to unshielded areas was found, as predicted. Polyethylene shielding has been installed to replace the heavier aluminum shielding used previously. Construction of the Booster Applications Facility at the Brookhaven National Laboratory continues on schedule and on budget. This facility will be used to simulate the space radiation environment for radiobiology research after it is commissioned in the third quarter of FY 2003.

**PROGRAM AREA PLANS FOR FY 2002**

BR will fund developmental work in the area of advanced pumps to develop Sabatier reactor technology for ISS. A fully developed Sabatier reactor has the potential to save the cost of transporting 2,000 lbs. of water annually to the Station by recycling carbon dioxide produced by the crew into water and methane. BR will continue to conduct research to enhance the health and safety of the astronauts working and living on the ISS by investigating potential health and medical risks to crew and by developing "countermeasures" to reduce risk and illness, prevent health problems completely, or establish the most beneficial rehabilitation programs for returning astronauts. The focused flight and ground research announcements released in FY 2001 will lead to an intensive research effort for the ISS in the following areas during FY 2002: (1) bone and muscle loss in space, and (2) crew performance (e.g. psychological and social issues, human factors, physiological changes). During FY 2002, BR will select investigations judged to be meritorious through a competitive peer-review process for the program and the National Space Biomedical Research Institute (NSBRI, a consortium of research institutions which conducts biomedical research on space flight issues); with funding beginning in early FY 2003. In FY 2002, 25 Bioastronautics Research experiments will be performed on 3 ISS increments (4, 5, and 6). The process of setting clear priorities for ISS research will continue, and the research emphasis and mix may be changed, considering the recommendations of the IMCE task force (the "Young Committee") working with the scientific community, advisory committees, and the Office of Science and Technology Policy. The STS-107 research mission will launch in the fourth quarter of FY 2002 with a code U payload theme of "health, safety and countermeasures."

**PROGRAM AREA PLANS FOR FY 2003**

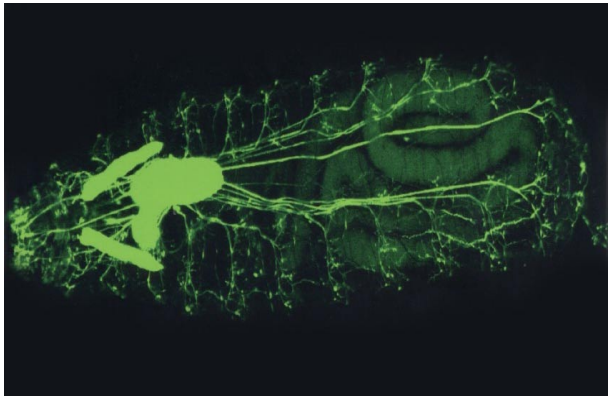
The Bioastronautics Research Program (along with the PSR and FSB programs) will accelerate BPR's efforts to develop knowledge, tools, and techniques to address the space radiation health problem. This "Space Radiation" initiative was prompted by the desire for an increased understanding of the effects of the radiation environment in low Earth orbit and beyond, where the radiation environment is much more hazardous, and by the establishment of more restrictive guidelines for astronaut exposure levels. The ground-based research initiative will generate knowledge, assess health risks to astronauts, and develop radiation shielding design tools, strategies, and countermeasures that can be employed aboard ISS and future space missions.

BR plans to develop advanced monitoring and control technologies to the point where they could be effectively tested and used in integrated test beds; develop air and water treatment technologies that will help reduce the equivalent system mass of the currently baselined ISS ECLSS (Environmental Control and Life Support Systems) technologies; solicit and fund low- and mid- range Technology Readiness Level (TRL) activities that will result in next-generation life support systems for the ISS and other low Earth orbit and long duration space missions; and develop tools that will result in better use and optimization of crew time on the ISS to increase science productivity. Such tools may include improved human-machine interfaces, crew restraints, and digital anthropometric data that could be implemented by 2003. BR will continue to conduct research to enhance the health and safety of the astronauts working and living on the ISS by investigating potential health and medical risks to crew and by developing "countermeasures" to reduce risk and illness, prevent health problems completely, or establish the most beneficial rehabilitation programs for returning astronauts. BR will fund investigations judged to be meritorious through a competitive peer-review process for the program and the NSBRI. During FY 2003, 17 Bioastronautics Research experiments will be performed on 3 ISS increments. Research priorities, developed during FY 2002, will be implemented in allocating resources for development and utilization of ISS research capabilities. An STS-107 science results workshop will be held during FY 2003. The program will also initiate the newly validated and prioritized research program content and continue ground-based and flight research in the validated and prioritized research areas.

**BASIS OF FY 2003 FUNDING REQUIREMENT**

**FUNDAMENTAL SPACE BIOLOGY PROGRAM**

| | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|
| | *(Millions of Dollars)* | | |
| **Research Program** | **40.6** | **35.3** | **56.0** |



Fluorescently stained nerve cells in a fruit fly used for studying how microgravity affects normal nervous system development.

**DESCRIPTION/JUSTIFICATION**

The Fundamental Space Biology (FSB) Program uses the environment of space to enhance our understanding of biology by providing a continuum of research that investigates the role of gravity and other space flight factors at all levels of biological processes. These include cell and molecular biology, developmental biology, organismal and comparative biology, gravitational ecology, and evolutionary biology. The understanding, development, and implementation of this research will provide the underpinnings necessary to support long-term human space flight.

**PROGRAM AREA**

**GOALS**

(1) Effectively use microgravity and the other characteristics of the space environment to enhance our understanding of fundamental biological processes;
(2) Develop the foundation of fundamental biological knowledge required to enable a long-duration human presence in space;
(3) Develop the biological understanding to support other biologically related NASA activities; and
(4) Apply this knowledge and technology to improve our nation's competitiveness, education, and the quality of life on Earth.

**CONTENT**

Ground-based and flight research grants, contracts, and interagency agreements are solicited and reviewed via a competitive peer review process supporting Shuttle and Space Station experiments to develop flight studies for Shuttle mid-deck missions and Space Station. These areas of focus are:

- Molecular Structures & Physical Interactions
- Cell & Molecular Biology
- Developmental Biology
- Neural Science
- Organismal and Comparative Biology
- Evolutionary Biology

- Gravitational Ecology

| Milestones | Plan in the FY 2003 Budget | Plan in the FY 2002 Budget | Plan in the FY 2001 Budget | FY 2002 - FY 2003 Change | Comment/Status |
|---|---|---|---|---|---|
| Award Grants From NRA 01-OBPR-03 | 2/02 | 2/02 | 2/02 | No change | |
| Release ground-based research NRA | 10/02 | 10/02 | 10/02 | No change | |
| Establish and Pursue Science Priorities | 8/02 Final Report | | | | Revalidation of scientific research content and prioritization |
| Research Experiments On STS-107 | 7/02 | 1st Quarter, FY 2002 | 5/00 | 7-9-month slip | Launch delays due to manifest changes |

**MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR**

During FY 2001, the transition of Fundamental Biology in the former Life Sciences Division to the Fundamental Space Biology (FSB) Division was completed. Strategic planning for the new division was carried out in conjunction with the Lead Center Program Office. During FY 2001, FSB funded 30 new ground research investigations, for a funding rate of approximately 20% of all applicants, and released a call for proposals (NRA) for ground-based research proposals to be funded in FY 2002. FSB also solicited flight research as part of the International Space Life Sciences Working Group (ISLSWG) flight solicitation. Collaborative efforts with the Astrobiology Program were carried out, including the funding of research at the National Astrobiology Institute. Increased integration and coordination of FSB with other components within BPR, including biomedical and biotechnology research, was implemented.

**PROGRAM AREA PLANS FOR FY 2002**

During FY 2002, FSB will increase fundamental knowledge in the biological sciences and address critical questions in crew health and safety by conducting flight investigations on the STS-107 Space Shuttle mission and ISS. These include investigations of the effects of gravity on plant growth and physiology, the effect of the space environment on bacterial virulence and gene expression, the effects of microgravity on avian development in space, on arterial functioning and vestibular adaptation, and the effects of gravity on plant photosynthesis and respiration. Six new Fundamental Space Biology flight investigations were selected for definition through the International Space Life Sciences Strategic Working Group peer review process. New ground-based research proposals, solicited through a call for proposals (NRA) released in FY 2001, will be funded.

During FY 2002, FSB will initiate planning for possible participation in a free-flyer research mission in FY 2004 using a Russian Bion research satellite in collaboration with the European, Canadian, and Japanese space agencies. Increased collaboration with other federal agencies will be pursued through participation in multi-agency activities.

**PROGRAM AREA PLANS FOR FY 2003**

The Fundamental Space Biology Program (along with the BR and PSR programs) will accelerate BPR's efforts to develop knowledge, tools, and techniques to address the space radiation health problem. This "Space Radiation" initiative was prompted by the desire for an increased understanding of the effects of the radiation environment in low Earth orbit and beyond, where the radiation environment is much more hazardous, and by the establishment of more restrictive guidelines for astronaut exposure levels. The ground-based research initiative will generate knowledge, assess health risks to astronauts, and develop radiation shielding design tools, strategies, and countermeasures that can be employed aboard ISS and future space missions.

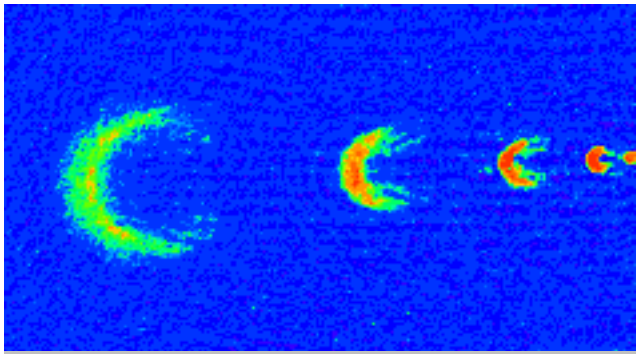
The FSB Program will initiate a new "Generations" project to study the adaptation of organisms to the space environment over several generations and the capacity of terrestrial life to evolve in space. The project will employ ground-based research and both the ISS and autonomous "free-flyer" platforms in different orbits, including High Earth Orbit beyond the Van Allen radiation belts that shield lower orbits from hazardous solar and galactic cosmic radiation. This will enable researchers to study the effects of the space flight environment on biological systems and processes, adding to fundamental knowledge, and may enable the development of countermeasures and life support technologies for future space missions.

The FSB program will also release a call for proposals (a NASA Research Announcement) for ground-based research. Support of currently funded flight investigations will continue and appropriate flight opportunities will be identified and pursued. ISS facilities development will continue. Assessing the use of free-flyers as space research flight platforms to augment the capabilities of the ISS will be conducted, including project planning for the proposed Russian Bion research mission, which will mature towards a projected launch in the latter half of FY 2004. The Program will also initiate the newly validated and prioritized research program content and continue ground-based and flight research in the validated and prioritized research areas.

**BASIS OF FY 2003 FUNDING REQUIREMENT**

**PHYSICAL SCIENCES RESEARCH PROGRAM**

| | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|
| | *(Millions of Dollars)* | | |
| **Research Program** | **130.4** | **120.0** | **134.1** |



Wolfgang Ketterle's Nobel-Prize-winning first atom laser producing pulses of coherent matter.

**DESCRIPTION/JUSTIFICATION**

The Physical Sciences Research (PSR) Program will combine unique experimental facilities with long-duration access to low-Earth orbit and beyond to enable new scientific discoveries and the development of technologies for the benefit of space exploration and Earth-based applications. The program is sponsoring peer-reviewed, interdisciplinary ground-based and flight research focusing on scientific issues and technological development that cannot be effectively addressed on Earth. The scope of the program includes the most recent and exciting areas of atomic and biomolecular physics and chemistry, groundbreaking research in biotechnology, and significant new developments in materials science, fluid physics, and combustion research. A unique component of the program is the cross-disciplinary research in the microgravity environment of space to increase understanding of those physical and chemical phenomena affecting biological systems that are masked by the effects of gravity on Earth.

**PROGRAM AREA**

**GOALS**

(1) to carry out groundbreaking, peer-reviewed, and multidisciplinary basic research enabled by the space environment to address NASA's goal of advancing and communicating knowledge;
(2) to develop a rigorous scientific capability bridging physical science and biology to address the Nation's human and robotic space exploration goals;
(3) to establish the International Space Station facilities as unique on-orbit science laboratories addressing targeted scientific and technological issues of high significance; and
(4) to enhance the knowledge base for Earth-bound technological and industrial applications.

**CONTENT**

The program employs ground-based and flight research grants, contracts, and interagency agreements solicited and reviewed via a competitive peer review process to support the development of flight studies and experiments for the Shuttle and Space Station. The areas of focus are: atomic and molecular physics; fluids physics and engineering; combustion research; biomolecular physics and chemistry; tissue engineering and cellular biotechnology; and structural biology.

| Milestones | Plan in the FY 2003 Budget | Plan in the FY 2002 Budget | Plan in the FY 2001 Budget | FY 2002 - FY 2003 Change | Comment/Status |
|---|---|---|---|---|---|
| STS-107 Flight Investigations<br>• Combustion Module 2 (CM-2)<br>• Mechanics of Granular Materials (MGM-3)<br>• Biotechnology Demonstration System (BDS-5)<br>• Critical Viscosity of Xenon (CVX) | 7/02 | 1st Quarter, FY 2002 | 5/00 | 7-9-month slip | Payloads are ready. Previous launch delays have been due to Shuttle manifesting changes. |
| • Physical Sciences NRA | Funding start | | | | First integrated annual NRA |
| • Establish and Pursue Science Priorities | 8/02 Final Report | | | | Revalidation of scientific research content and prioritization |

**MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR**

PSR-funded researchers have been involved in the experimental control of light motion: the stopping, holding, and releasing of light has been demonstrated using lasers developed by a BPR investigator ("Physical Review" Letters, January 29, 2001, Vol. 86, Issue 5). Wolfgang Ketterle, a Fundamental Physics investigator, won the 2001 Nobel Prize in Physics for Bose-Einstein Condensation research. A study in materials science prompted the development of a new approach for suspending fine particles in fluids, which may have applications for the electronics, paint, cosmetics and pharmaceutical industries ("Proceedings of the National Academy of Sciences," July 2001).

By spinning ultra-cold sodium gas in a laboratory, BPR-funded scientists at the Massachusetts Institute of Technology (MIT) created a gas cloud riddled with tiny whirlpools like those that cause "starquakes." Thus, they created a physical model of processes taking place inside distant stars. A research group at MIT grew heart tissue with "significantly improved" structural and electrophysiological properties, using NASA bioreactor technology ("Journal of Physiology-Heart and Circulatory Physiology," Jan. 2001). StelSys (a joint venture of FVI and In Vitro Technologies) signed an agreement with NASA to explore the commercial applications of bioreactor technology research, specifically in areas related to biological systems. As part of its efforts to develop an artificial liver system for patients suffering from liver damage, StelSys will conduct a space flight experiment using liver tissue in May 2002.

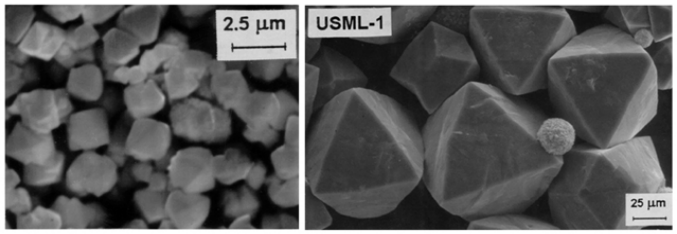
**PROGRAM AREA PLANS FOR FY 2002**

PSR will carry out manifested investigations in combustion research, fluid physics, and biotechnology on the STS-107 mission. The program will continue the development and fabrication of the Fluids Integrated Rack (FIR), the Combustion Integrated Rack (CIR), and the Materials Science Research Rack-1 (MSRR-1) for delivery and launch in 2004 and 2005. PSR will continue the development of the Biotechnology Facility (BTF) experiment inserts and the Low Temperature Microgravity Physics Facility (LTMPF) for delivery and launch in 2006. It will also initiate on-orbit research activities in the Microgravity Science Glovebox to be launched in the third quarter of FY 2002. The first flight of the liver tissues by the commercial venture in NASA research facility scheduled for May 2002. Also, PSR will release the first annual integrated call for proposals (NRA) in Physical Sciences and carry out the peer review and selection of proposals. The program will: continue the planned on-orbit ISS research in EXPRESS racks during Expeditions 4, 5, and 6; carry out a total program research validation and prioritization process; and peer review and select a Bioscience and Engineering Institute.

**PROGRAM AREA PLANS FOR FY 2003**

The Physical Sciences Research Program (along with the BR and FSB programs) will accelerate BPR's efforts to develop knowledge, tools, and techniques to address the space radiation health problem. This "Space Radiation" initiative was prompted by the desire for an increased understanding of the effects of the radiation environment in low Earth orbit and beyond, where the radiation environment is much more hazardous, and by the establishment of more restrictive guidelines for astronaut exposure levels. The ground-based research initiative will generate knowledge, assess health risks to astronauts, and develop radiation shielding design tools, strategies, and countermeasures that can be employed aboard ISS and future space missions.

PSR plans to analyze STS-107 flight experiment results. It will continue fabrication of ISS research racks and experiment inserts for the CIR, FIR, and MSRR-1. PSR plans to carry out manifested ISS research investigations in EXPRESS Racks and the Microgravity Science Glovebox in order to process the already selected flight investigations in the queue. The program will also initiate the newly validated and prioritized research program content and continue ground-based and flight research in the validated and prioritized research areas.




Zeolite crystals on Earth (left) and in space (right); space crystals are larger, have fewer defects, and are more ordered in structure. Improved crystals benefit refining, chemical processes, and other applications.

**BASIS OF FY 2003 FUNDING REQUIREMENT**

**SPACE PRODUCT DEVELOPMENT PROGRAM**

| | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|
| | *(Millions of Dollars)* | | |
| **Research Program** | **29.2** | **17.0** | **14.8** |

**DESCRIPTION/JUSTIFICATION**

The Space Product Development (SPD) Program is implemented primarily through Commercial Space Centers (CSC). Each CSC is a non-profit consortium of commercial and academic entities, and some also include government agency participation. The CSCs follow business leads and commitments to pursue product-oriented research in three major disciplines: materials research and development, biotechnology, and agriculture. NASA's role in this partnership is to provide leadership and direction for the integrated program and to provide the flight opportunities that are essential to the success of these efforts.

**PROGRAM AREA**

**GOALS**

(1) facilitate the use of space for the development of commercial products and services (including appropriate supporting ground-based activities);
(2) couple NASA and private sector technology development to the advantage of both; and
(3) promote the benefits of space-based research to industry, facilitate industry's access to space, provide space research expertise and flight hardware, and advocate the development of policies to encourage the commercial use of space.

**CONTENT**

SPD supports the operation of the NASA Commercial Space Centers (CSC), along with the development of commercial flight research hardware for Space Shuttle and the International Space Station (ISS). SPD provides ground-based and parabolic aircraft flight opportunities for initial commercial research efforts.

The CSCs initiate industry involvement in two ways: (1) by identifying and investigating industry-led research areas of commercial promise; and (2) by assessing markets for these potential research opportunities. The businesses support the research effort with cash and in-kind resources, such as technical expertise, research materials, personnel, ground facilities, and research hardware.

| Milestones | Plan in the FY 2003 Budget | Plan in the FY 2002 Budget | Plan in the FY 2001 Budget | FY 2002 - FY 2003 Change | Comment/Status |
|---|---|---|---|---|---|
| Annual Report Published | 2/04 | 2/03 | 2/02 | NA | Report on annual basis by February |
| Performance Review of CSCs initiated | 3/02 | 3/02 | | No change | Continual reviews beginning in FY 2002 according to the following: Five CSCs reviewed in 2002, five in 2003, and five in 2004 |
| Fly 6 Commercial Payloads on STS-107 | 7/02 | 1st Quarter, FY 2002 | 5/00 | 7-9-month slip | Launch delays due to manifest changes |
| Consolidate Management of CSC Program | 11/01 | | | | Four CSCs transferred from the Aerospace Technology Enterprise November 2001 |

**MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR**

A private company, Space Hardware Optimization Technology, Inc. (SHOT) of Greenville, Indiana, signed an agreement March 19 with NASA that allows the company to conduct flight experiments for commercial customers on the agency's Space Shuttle missions. It is now one of only four non-university-based companies in the Nation with such an agreement with NASA. One of NASA's objectives is to promote an increase in the use of space for commercial products and services. SHOT's independent marketing of space for industrial research helps NASA and SPD meet that objective.

The ProVision Technologies (PVT) CSC began work with the Federal Bureau of Investigation (FBI) Academy. A Memorandum of Understanding (MOU) between the FBI and NASA was signed and placed on the cooperative agreement as of September 30, 2001. This research activity will involve the construction of a hyperspectral imaging system with visible and near-infrared capabilities, training on the system for the FBI Academy, as well as some exploratory image acquisition and processing. The application will be in forensic examination of passports, documents, fingerprints, currency, and other evidentiary items, comparing dyes and inks.

**PROGRAM AREA PLANS FOR FY 2002**

At the beginning of FY 2002, BPR consolidated the management of the Commercial Space Centers (CSCs) within the structure of the SPD office. Management of both the Commercial Space Center for Engineering (CSCE) and ProVision Technologies (PVT) CSCs were transferred into the SPD office at Marshall Space Flight Center (MSFC). In addition, preparations were completed for transfer of the four “infrastructure” CSCs into SPD as they were released by NASA’s Aerospace Technology Enterprise and picked up by BPR.

Specific research efforts continuing into FY 2002 include Advanced Astroculture (deployed on ISS 6A and again on UF-1), which explores “seed-to-seed” generational research in microgravity. Future flight activity will also examine microgravity genetic engineering on plants with the goal of improved plant growth research in the Advanced Astroculture unit, which was developed by

the Wisconsin Center for Space Automation and Robotics. This agriculture research expands our knowledge of closed environment system technology performance in a microgravity environment over long duration, and provides an important laboratory for improved crop development in a multi-billion dollar market.

The Commercial Generic Bioprocessing Apparatus (CGBA) will build on prior research conducted aboard Shuttle missions (STS-77 and STS-95) that achieved substantial levels of improvement in the rate of bacterial production compared to ground based samples (200% increase on STS-77, 75% increase on STS-95 in a different antibiotic arena). There will be additional research conducted on the International Space Station (ISS 8A) to replicate this increased production rate. These results may enable Bristol-Myers Squibb, the commercial partner to BioServe Space Technologies, to greatly increase its antibiotic production capability through newly developed fermentation methods. A 1% increase in process efficiency could result in the savings of millions of dollars in annual production costs for the company.

In sum, FY 2002 will see several commercial research payloads that had positive results aboard Space Shuttle missions flown on Station to build on these results with the commercial partners. There will also be new payloads designed for the ISS, such as the Zeolite Crystal Growth Furnace, that will make use of the extended duration capability of the ISS.

**PROGRAM AREA PLANS FOR FY 2003**

SPD will continue to perform CSC and ISS research, such as Zeolite Crystal Growth (ZCG) sample processing, genetic engineering research through the Advanced Astroculture Unit, and biomedical protein crystal growth research. New materials processing capabilities, such as the VULCAN combustion unit and the Space-DRUMS unit for high temperature material processing research, will be deployed. The ISS will continue the essential transition of research from the limited duration Shuttle sortie era to the long-duration experimentation made possible by the permanent presence of an orbiting laboratory. This ongoing access to microgravity research and the establishment of permanent facilities for commercial research efforts (ZCG, VULCAN, Space-DRUMS, etc.) represents NASA's commitment to its mandate under the Space Act to support the commercial use of space. It is envisioned that the ongoing research presence of such a capability will greatly strengthen the commercial partnerships with the Commercial Space Centers and advance the biomedical, agriculture, and materials processing product development efforts.

Lastly, development will continue on next-generation hardware to carry into the Station era the research efforts begun under the Shuttle program, such as Space Automated Bioproduct Lab (SABL, follow-on to the CGBA hardware) and the Commercial Plant Biotechnology Facility as complementary commercial research hardware to Advanced Astroculture.

The Program will also initiate the newly validated and prioritized research program content and continue ground-based and flight research in the validated and prioritized research areas.

**BASIS OF FY 2003 FUNDING REQUIREMENT**

**OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER**

| | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|
| | | *(Millions of Dollars)* | |
| **Agency Health and Medical Program** | **3.3** | **3.9** | **3.9** |

**DESCRIPTION/JUSTIFICATION**

The Office of the Chief Health and Medical Officer (OCHMO) was established in May 2000 to assist the Administrator in ensuring the health and safety of NASA employees in space and on the ground. The OCHMO is responsible for health policy formulation and oversight for all health and medical activities in the Agency, including oversight of healthcare delivery and professional competency, the establishment of standards of practice, and the assurance of consistent, quality occupational health services and medical care.

**PROGRAM AREA**

The Chief Health and Medical Officer (CHMO) is the principal advisor to the Administrator and other senior officials on all health and medical issues affecting NASA employees. The CHMO provides oversight of health care delivery and professional competency, ensuring quality and consistency of service Agency-wide. The CHMO also provides oversight of the process ensuring the safe and ethical execution of research involving human and animal subjects, and serves as the Agency medical waiver authority for atmospheric and space flight crews. The CHMO oversees the final review and evaluation of health research products and supporting clinical evidence prior to delivery to the operational community for further development and implementation.

The OCHMO's Agency Occupational Health and Agency Space Medicine programs cover the office's responsibilities for: 1) Agency health and medical policy; 2) oversight of overall medical quality assurance; 3) oversight of medical protection of research subjects and patients; 4) chairing the Agency Medical Policy Board and Health Council; 5) oversight of Agency occupational health programs; 6) oversight of professional development of NASA healthcare providers (including professional education and credentials verification); and 7) development and oversight of NASA medical and health-related research requirements review process and deliverables.

**GOALS**

(1) Enhance and continue to improve astronaut physical training, preflight conditioning, and post-flight rehabilitation as a critical part of the permanent human presence on the International Space Station;
(2) Acquire knowledge about the risks to human health during space flight beyond Earth's orbit and make all reasonable efforts to effectively mitigate those risks;
(3) Increase health threat awareness and readiness to defend against bioterrorism; and
(4) Implement physician credentialing as part of medical quality assurance.

**CONTENT**

In order to ensure the availability of appropriately trained aerospace medicine physicians, the OCHMO supports the only civilian pipelines for aerospace physicians through the Wright State Residency Program in Dayton, Ohio and the University of Texas, Medical Branch in Galveston. Through the Occupational Health Program (OHP), the OCHMO will continue to support occupational health initiatives, environmental and occupational medicine efforts, health threat awareness training, and occupational health education and training for employees across the Agency.

| Milestones | Plan in the FY 2003 Budget | Plan in the FY 2002 Budget | Plan in the FY 2001 Budget | FY 2002 - FY 2003 Change | Comment/Status |
|---|---|---|---|---|---|
| Medicine of Extreme Environments IPA | January 2002 | January 2001 | January 2001 | 1 year slip | Difficulties associated with bringing on a foreign national to University of Texas – Medical Branch delayed arrival of IPA |
| Physician Credentialing Program | March 2002 | Sept. 2001 | Sept. 2001 | 6 Month slip | Software training and hardware acquisition delays forced deferral to FY 2003 |
| First round of Center occupational health assessment visits | October 2001 | October 2001 | October 2001 | None | Completed |
| Web-based stress management training modules | | June 2001 | June 2001 | None | Completed |

**MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR**

With the successful completion of the first two ISS increments, Space Medicine shifted attention to worldwide long-duration operations, countermeasures to the environment of space, on-orbit medical certification and intervention, and comprehensive rehabilitation services post-flight. A behavioral health program was implemented to support ISS crewmembers and their families. This support included cross-cultural training, and cognitive and fatigue self-assessment to enable maximum performance and safety of crewmembers. The OCHMO commissioned a group of experts to evaluate and recommend for or against the efficacy of screening astronauts for congenital patent framen ovale (PFO, a physiologic condition that is potentially significant for astronauts performing EVAs). As a result, one of the first major policy decisions impacting the astronaut corps was to recommend against broad-based PFO screening because the risk of the screening procedure outweighs the benefit provided by the screening. The Occupational Health Program (OHP) restructured its award-winning Website with increased training modules, hot links, and medical alerts. Web metrics on an employee stress management module with embedded stress questionnaire documented the largest number of access hits in a single quarter, indicating widespread use by employees. A major medical first responders course received increased attention after the terrorist attacks of September 11 and the anthrax bioterrorism that followed. The OHP immediately stepped up

dissemination of its not-yet-released general employee health threat awareness training. The OCHMO began unprecedented open discussion fora with employees at HQ, which were taped and broadcast repeatedly at the Centers.

**PROGRAM AREA PLANS FOR FY 2002**

In November 2001, the Institute of Medicine released its report on future space crew health, "Safe Passage". The report noted that there remains insufficient knowledge about the risks to human health in space flight and urges NASA to develop a comprehensive health care system, using an occupational health module, that captures all relevant clinical and epidemiological data, and to develop a focused health care strategy to define and ameliorate risks. With a newly hired external expert (hired through an Interagency Personnel Agreement, or IPA) for Medicine of Extreme Environments, NASA will concentrate on evolving health and medical care from remote, extreme environments on Earth to the environment of low Earth orbit and beyond. Physician credentialing is expected to be an integrated part of NASA's medical quality assurance system before the close of the calendar year. The Occupational Health Program will sponsor its second-ever joint Health and Safety conference and its fourth Occupational Health Conference since the principal Center was established. Finally, the threat of bioterrorism attacks will be met with increased security in the form of increased awareness, and enhanced detection and protection capabilities.

**PROGRAM AREA PLANS FOR FY 2003**

The OCHMO plans to further develop astronaut psychosocial support through its behavioral health programs, and will continue to refine its physical training, preflight conditioning, and post-flight rehabilitation efforts. Occupational Health training efforts will continue in both stress management and threat awareness training. Medical quality assurance efforts will ensure ongoing updates and refinement of the Centers' assessment instrument, and continue with credentialing efforts for NASA physicians.

## BASIS OF FY 2003 FUNDING REQUIREMENT

### BIOLOGICAL AND PHYSICAL RESEARCH INSTITUTIONAL SUPPORT

| | FY 2001 | FY 2002 | FY 2003 |
|---|---|---|---|
| | (Millions of Dollars) | | |
| **Institutional Support to the Biological and Physical Research Enterprise** | | | |
| Research and Program Management (R&PM)..... | 42.6 | 156.3 | 154.4 |
| Personnel and Related Costs..... | 32.4 | 124.8 | 126.6 |
| Travel..... | 1.3 | 3.2 | 3.2 |
| Research Operations Support..... | 8.9 | 28.3 | 24.6 |
| Construction of Facilities..... | 6.8 | 14.7 | 19.0 |
| **Full-Time Equivalent (FTE) Workyears** | **427** | **1,242** | **1,273** |

Note: FY 2001 data in this section are for comparison purposes only and do not include ISS Research.

## PROGRAM GOALS

The two primary goals of this budget segment are to:

1. Acquire and maintain a civil service workforce that reflects the cultural diversity of the Nation, and is both sized and skilled consistently with accomplishing NASA's research, development, and operational missions with innovation, excellence, and efficiency for the Biological and Physical Research Enterprise.
2. Ensure that the facilities critical to achieving the goals of the Biological and Physical Research Enterprise are constructed and continue to function effectively, efficiently, and safely, and that NASA installations conform to requirements and initiatives for the protection of the environment and human health.

**RESEARCH AND PROGRAM MANAGEMENT (R&PM):** This program provides the salaries, other personnel and related costs, travel, and the necessary support for all administrative functions and other basic services in support of research and development activities at NASA installations. The salaries, benefits, and supporting costs of this workforce are covered in the Personnel budget, which comprises approximately 82% of the requested R&PM funding. Research and Operations Support (ROS), which covers administrative and other support, is approximately 16% of the request. The ROS budget funds system management offices (SMOs)

at all field Centers. The SMOs work with all Center programs to improve system engineering and cost estimating processes. The FY 2002 funding estimate for ROS includes $4.5M provided in the Emergency Supplemental to enhance NASA's security and counter-terrorism capabilities; the FY 2003 funding plan is $1.2M. The remaining 2% of the R&PM request is required to fund the travel necessary to manage NASA and its programs.

**CONSTRUCTION OF FACILITIES (CoF):** This budget line item provides funding for discrete projects required by components of NASA's basic infrastructure and institutional facilities; almost all CoF funding is used for capital repair. NASA facilities are critical for the support of research conducted by the Biological and Physical Research Enterprise. NASA has conducted a thorough review of its facilities infrastructure, and determined that, 1) the deteriorating plant condition warrants increased repair and renovation efforts in order to avoid safety hazards to personnel, facilities, and mission, and 2) some dilapidated facilities need to be replaced. Increased investment in facility revitalization is required to maintain an infrastructure that is safe and capable of supporting NASA's missions.

## ROLES AND MISSIONS

The detail provided below is for the support of the Biological and Physical Research Enterprise institutions: Johnson Space Center (JSC), Kennedy Space Center (KSC), Marshall Space Flight Center (MSFC), Ames Research Center (ARC), Langley Research Center (LaRC), Glenn Research Center (GRC), Goddard Space Flight Center (GSFC), Jet Propulsion Laboratory (JPL), and NASA Headquarters.

### JOHNSON SPACE CENTER (JSC)

The Biological and Physical Research Enterprise funds approximately 6.6% of JSC's institutional budget. JSC is the Lead Center for developing and implementing International Space Station Research Capability (ISSRC), which encompasses the research-discipline-based facility development and utilization, multi-user systems support for the science, and technological and commercial payloads using ISS as a research platform. The ISSRC includes the development of research facilities, experiment-unique equipment, multi-user payload hardware, and the ground facilities, software, and tools to implement the utilization tasks. Utilization support services are provided to both U.S. and International Partners, and include services for payload planning and engineering support, crew and user team training, sub-rack- and sub-pallet-level payload integration, ground processing, and on-orbit payload operations for all research related hardware and software on-board the ISS. JSC coordinates all Performing Center activities for ISSRC.

JSC is the Lead Center for implementing Advanced Human Support Technology and Biomedical Research & Countermeasures work, as well as providing the mission implementation function for Headquarters research mission activities. JSC coordinates all Performing Center activities, manages Advanced Life Support facilities, and conducts all system-level integration and testing for these facilities. JSC also manages the significant ground-based grant activities and all flight experiment activities focused on human research. Countermeasures-focused research is managed by a cooperative agreement between JSC and Baylor College of Medicine. This agreement governs the National Space Biomedical Research Institute (NSBRI), a 12-university consortium managed

by Baylor College of Medicine and JSC, in developing countermeasures. JSC manages clinical medical and psychological support for the astronauts as well as telemedicine efforts in support of medical operations activities for the Human Space Flight (HSF) Program.

Finally, JSC is also a Performing Center for Fundamental Space Biology, Physical Sciences Research, Space Product Development, Mission Integration, and the Agency Space Medicine Program.

**KENNEDY SPACE CENTER (KSC)**

The Biological and Physical Research Enterprise funds approximately 1.1% of KSC's institutional budget. Kennedy Space Center manages extramural research and conducts specific research tasks directed at using plants in advanced life support systems. KSC also provides pre- and post-flight support for Biomedical Research & Countermeasures and Fundamental Space Biology flight experiments. KSC is a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, Fundamental Space Biology, ISS Research Capability, and the Agency Occupational Health Program.

**MARSHALL SPACE FLIGHT CENTER (MSFC)**

The Biological and Physical Research Enterprise funds approximately 17.5% of MSFC's institutional budget. Marshall Space Flight Center is the location of the ISS Payload Operations and Integration Center (POIC), and is the Lead Center for Physical Sciences Research's Fundamental Microgravity Research, and Biotechnology and Earth-Based Applications. The Microgravity Research Program Office (MRPO) at Marshall also manages Space Product Development. Marshall is also a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, Fundamental Space Biology, and ISS Research Capability.

**AMES RESEARCH CENTER (ARC)**

The Biological and Physical Research Enterprise funds approximately 9.9% of ARC's institutional budget. Ames Research Center is the Lead Center for implementing Fundamental Space Biology, and plans are to designate ARC as the Lead Center for Physical Sciences Research's Biomolecular Physics and Chemistry efforts in FY 2002. Ames supports biomedical research investigations, and plays the primary life sciences role in the development of biomedical flight experiments requiring non-human subjects. ARC manages extramural research and conducts specific research tasks directed at analytical models and physicochemical processes for advanced life support systems. Ames is also a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, and ISS Research Capability.

**LANGLEY RESEARCH CENTER (LaRC)**

The Biological and Physical Research Enterprise does not fund LaRC's institutional budget due to the limited amount of BPR work performed at the Center. LaRC is a Performing Center for Physical Sciences Research and ISS Research Capability.

**GLENN RESEARCH CENTER (GRC)**

The Biological and Physical Research Enterprise funds approximately 12.4% of GRC's institutional budget. GRC is a Performing Center for Physical Sciences Research and ISS Research Capability.

**GODDARD SPACE FLIGHT CENTER (GSFC)**

The Biological and Physical Research Enterprise does not fund GSFC's institutional budget; the grant-related work for GSFC is done at NASA Headquarters. GSFC is a Performing Center for Advanced Human Support Technology, Physical Sciences Research, and Space Product Development.

**JET PROPULSION LABORATORY (JPL)**

The Biological and Physical Research Enterprise funds approximately 2.7% of JPL's institutional budget. JPL is the lead for Advanced Environmental Monitoring and Control activities, bringing its personnel and industry contacts to the development of sensors and monitoring and control capability. JPL is a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, Physical Sciences Research, Mission Integration, and ISS Research Capability.

**NASA HEADQUARTERS**

The Biological and Physical Research Enterprise funds approximately 3.1% of NASA Headquarters' institutional budget. NASA Headquarters is the Lead Center for planning and directing Mission Integration. The Enterprise's Institutional Support figure includes an allocation for funding Headquarters activities based on the relative distribution of direct FTEs across the Agency. The Headquarters-based Office of the Chief Health and Medical Officer manages the Agency Occupational Health and Agency Space Medicine programs.